

DOCUMENT RESUME

ED 236 027

SE 043 308

AUTHOR Tasker, Ross, Ed.; Lambert, John, Ed.
TITLE Science Activities: Wider Issues--Some Considerations. Learning in Science Project. Working Paper 49.
INSTITUTION Waikato Univ., Hamilton (New Zealand).
PUB DATE Nov 81
NOTE 33p.; For related documents, see ED 226 976, ED 229 442, ED 230 594, ED 235 011-030, SE 043 285-302, and SE 043 305-315.
AVAILABLE FROM University of Waikato, Science Education Research Unit, Hamilton, New Zealand.
PUB TYPE Reports - Evaluative/Feasibility (142) -- Reports - Research/Technical (143)
EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Comprehension; Concept Formation; Concept Teaching; *Curriculum Development; Elementary School Science; Elementary Secondary Education; *Individualized Instruction; Learning; *Pacing; Science Education; *Science Instruction; Science Programs; *Secondary School Science; Teaching Methods
IDENTIFIERS *Learning in Science Project; *New Zealand; Science Education Research

ABSTRACT

Learning in Science Project findings have highlighted the quality of interaction between students and teachers as the key to effective learning. Major aspects of this interaction include focusing attention, linking to children's science, encouraging discussion, guiding investigations, challenging ideas/findings, and helping the restructuring process. Although different instructional approaches have been noted (from teacher-paced/teacher-directed to student-paced/student-directed), a compromise in approach is suggested to provide the best learning opportunities for all students. Such flexibility raises questions on when, with whom, how, and what students will learn as well as issues related to the aims of science teaching and priority given to the aims. In addition, consideration should be given to the fact that students in general appreciate a variety of learning experiences and that teaching should provide the opportunity for teachers to experiment. To help teachers in developing a student-paced program, a planning guide is provided in an appendix. Included in the seven-section guide are discussions of major factors to consider, possible approaches to student-paced instruction, practical considerations, producing a program, planning a topic, implementing the program, and several issues based on the authors' experiences. (JN)

* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *

ED236027

LEARNING IN SCIENCE PROJECT

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

✓ This document has been reproduced as
received from the person or organization
originating it.

□ Minor changes have been made to improve
reproduction quality.

• Points of view or opinions stated in this docu-
ment do not necessarily represent official NIE
position or policy.

SCIENCE ACTIVITIES

Wider issues – some considerations

"PERMISSION TO REPRODUCE THIS
MATERIAL IN MICROFICHE ONLY
HAS BEEN GRANTED BY

Roger Osborne

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)."

University of Waikato
Hamilton, N.Z.

SE043308

WORKING PAPER 49

This paper is part of a set of four papers that deal with the work of the Science Activities Action Research Group. The set is:

- | | |
|-------|--|
| No.46 | Science Activities: Report on the Science Activities Action Research Group |
| No.47 | Science Activities: The Problem. |
| No.48 | Science Activities: Specific Problems - some solutions |
| No.49 | Science Activities: Wider Issues - Some considerations |

RELATED LISP PAPERS

- | | |
|-----|---------------------------|
| No. | Focus on Experiments |
| No. | Focus on Process Skills |
| No. | Visit to a Classroom No.1 |
| No. | Visit to a Classroom No.2 |
| No. | Visit to a Classroom No.3 |
| No. | Visit to a Classroom No.4 |

SCIENCE ACTIVITIES : WIDER ISSUES - SOME CONSIDERATIONS

Ross Tasker and John Lambert (editors)

November 1981

Introduction

In the Learning in Science Project, many lessons have been observed, and hundreds of teachers and pupils have talked to us about their teaching or learning experiences in science classrooms. One of the key issues, both for teachers and pupils, has been the limited opportunities, available in classrooms, for pupils to have their ideas relating to things in science, challenged and modified by their learning experiences.

After observing a wide variety of teaching methods from chalk and talk, whole-class activities to long-term, self-paced individualised approaches (see Table 1), we are left quite unsure as to the best teaching methods to resolve this problem.

<u>1. Self-paced versus teacher-paced</u>			
long term self-paced	medium term self-paced	short term self-paced	teacher paced
<u>2. Individualized versus class-grouped study</u>			
Individuals all working on different tasks	Individuals working within a flexible arrangement	Individuals working within a fixed group	Whole class working on the same tasks
<u>3. Independent versus Dependent learning</u>			
Freedom to choose how when what to learn	Freedom to choose when to learn	No freedom to choose how when what to learn	

Table 1. Three parameters that describe a teaching approach.

For example, in the chalk and talk classroom it is so easy for the pupils to "switch-off". However, in the individualized classroom it is so easy for the pupil to absorb him or herself in trivial "busy-work". In both of these situations, the main intellectual points so essential to really gaining worthwhile and meaningful understanding are missed.

In one sense the problem is simply a practical one. With a teacher-pupil ratio of one to one there would be no problem, yet with a teacher-pupil ratio of one to thirty, the problems seem insurmountable at times.

What can we say from our experiences in the Learning in Science Project?

SECTION A Thinking through some basic issues

The Learning in Science Project findings have highlighted the quality of interaction between pupils and teachers as the key to effective learning. Let us explore what we consider are some of the essential elements in this interaction with regard to one possible aim of science, that is to modify children's intuitive ideas¹ toward a more scientific perspective. Let us further, within this aim, take a specific example of a lesson designed to modify children's views about what happens to the water left on a wet dish lying on the kitchen bench.

Learning in Science Project Research indicates the following are key aspects in teacher/pupil interaction;

1. Focussing attention

The first task for the teacher in any unit of work or activity is to direct pupil attention to an event or phenomena in such a way that pupils are clear of the problem that is to be focussed on and acquire interest and motivation to explore the problem. For example, all pupils might be given a wet dish and asked to observe it closely and record exactly what they see happen, and to think about why it happened.

1 'Ideas' is being used here in a very broad sense. It may involve a wide variety of objectives, for example knowledge, understanding, practical skills, intellectual skills of problem solving (both theoretical and experimental), scientific habits, or even an outlook on science.

2. Linking to children's science

For anyone to modify their views or way of thinking, it is important for the person to clarify in his or her own mind what their present view is. The teacher must provide a climate in the classroom where pupils can express openly the way they really think about things: for example, what their present view is about what happens on the dish. From one interview work, we have become aware that children do have views about familiar everyday experiences and the opportunity must be provided for pupils to link to these views.²

3. Encouraging discussion

An important and often overlooked task of a teacher is to not only encourage pupils to think through their own views, but to be prepared to listen to other viewpoints and to attempt to assess the advantages and disadvantages of these alternative views. For example, the view 'the water goes into the plate' could be checked by weighing the plate. Where appropriate, the teacher may feel it desirable to suggest to pupils the consensus scientist's view as a possible alternative that they might like to think about and discuss³. Good intellectual discussion is at the very heart of scientific inquiry and needs to be encouraged in our classrooms.

4. Guiding investigations

Where appropriate investigations develop out of Issues 1, 2 and 3 it is essential that all pupils involved in the activity are clear about the purpose of the activity, what the results of the investigation will or will not tell them, and what the critical design features of the investigation are with respect to the purpose of the investigation. The investigation may be to establish the usefulness of a particular viewpoint or to challenge

2 With regard to the water on the dish, typical views are 'The water has just dried up', 'it has gone into the plate', 'it has changed into air', 'it has changed into oxygen and hydrogen'.

3 This needs to be provided in language appropriate to children's experiences, for example, 'little wee drops of water, each so small that you can't see them, go into the air and move around in the air. Air contains small drops of water'.

a particular viewpoint. Activities suggested or considered by the pupils need to be moulded by the teacher to match available resources, and to meet the rigour of scientific inquiry. For example, can we weigh the plate sufficiently accurately to tell us whether the water has gone into the plate?

5. Challenging ideas and findings

Pupils must be challenged to critically consider the findings that they extract from a discussion, from written materials, or from an investigation; not only in the light of evidence provided, but in terms of their expectations. Pupils need to be forced to reflect on the significance or otherwise of what they did and what they found out, and to think about how this influences their ideas and ways of thinking about things. For example, if the water did not go into the plate, what happened to it?

6. Helping the restructuring

If all the above is successful in challenging pupils' views and in modifying children's views in a way which is useful to them, then the experience will raise new questions and new issues to be discussed and investigated. Pupils need time to come to grips with new ideas. For example, if little wee bits of water, each so small that you can't see them, move about in the air, what happens to them? Where do they go to? Is the air getting more and more water in it all the time?

The six aspects that we raise here are what we believe to be the key issues if children are to have valuable learning experiences in science classrooms related to what we consider to be worthwhile and important science education objectives. Whatever the teaching approach, for example small group or whole class activities, we believe that the above can only be achieved through active involvement of the teacher with the pupils.

SECTION B Considering the diversity of teaching approaches

As indicated earlier, it is our opinion that with teacher-pupil ratios of around 1 to 30, no single teaching approach is able to

provide ideal learning opportunities for all pupils at all times. We have observed a range of teaching approaches. These approaches include:

- (1) teacher paced and teacher directed
i.e. all pupils are provided with the same learning opportunities at the same time and at the same rate
- (2) pupil paced and teacher directed
i.e. all pupils are provided with the same learning opportunities, but the rate at which these opportunities are provided is different for different pupils
- (3) partly pupil paced and partly teacher paced but teacher directed
i.e. all pupils are provided with the same learning opportunities at the same or different rates, at some stages, but different learning opportunities for different pupils at other stages
- (4) pupil paced and pupil directed
i.e. pupils choose different learning opportunities on the basis of interest, intellectual ability and other criteria and control the rate of these opportunities

Characteristic of all the above approaches is that different pupils learn different amounts.

Clearly in order to provide the best learning opportunities for all our pupils some compromise in approach is necessary. This does not mean a 'for all time' decision on the part of the teachers about which approach should be used. Rather, we see the decision as being 'where and when should I be using which approach?' and this decision, naturally, depends on a teacher's strengths and weaknesses as a teacher, the particular topic to be taught and the resources available to teach that topic, the nature of the class - streamed or unstreamed - and the institutional philosophy, e.g. all pupils will sit a common examination; as well as practical considerations, e.g. 'are all the science lessons in the same room?' and 'do I have enough time to prepare various learning experiences for different pupils?'

If the need for flexibility in teaching approach is accepted then the second set of decisions to be made relate to the question:

How much flexibility should there be in my teaching programme?

Again there is no simple answer and each teacher must make the final decision herself after consideration of the following issues:

1. When will pupils learn
 - are lessons to be long-term self-paced (more than 2 weeks), medium-term self-paced (1 or 2 weeks), short-term self-paced (1 or 2 lessons), teacher-paced (each lesson)?
2. With whom will pupils learn
 - are pupils to work individually, work in flexible group arrangements, work in fixed groups, work as a class?
3. How will pupils learn
 - are lessons to be teacher led, or led by written-materials; and what type of learning experiences will they involve, e.g. small group discussion, class discussion, teacher led experiment?
4. What will pupils learn
 - are the topics to be studied, teacher-chosen or pupil-chosen? Are different pupils to study the same topic or different topics?

Note: Decisions relating to the above issues cannot be made independent of each other. A decision on one issue will have an influence on one or more of the other issues.

SECTION C Facing even more basic issues

The previous discussion relating to when, with whom, how and what pupils are to learn leads us back to confront a more basic issue. What really are the aims, or our aims, for teaching science? What priority do we give to each of these aims?

Do we wish to stress knowledge and understanding objectives? If so, do we wish to expose pupils to a wide range of children's and

scientists' views of the world or do we wish them to study in-depth, and at their own pace, some particular aspect of science?

Do we wish to stress 'investigating' objectives? If so, do we wish to stress experimental techniques e.g. measuring, observing, or the skills of identifying a problem and designing experiments to solve that problem, e.g. project work.

Do we wish to stress 'attitudinal' objectives? If so, are we more concerned with pupils having a positive attitude to science lessons, e.g. by enabling pupils to interact with their peers, or with developing a positive attitude to science and scientists, e.g. by gaining satisfaction in really appreciating a good scientific theory?

Do we wish to achieve all objectives with all pupils? For example, some children are interested in scientific explanations about how and why things behave as they do, while other pupils are much more interested in technology.

All these issues raise questions about the learning opportunities pupils should have and about whether there should be the same learning opportunities for all. How do we decide on which learning opportunities for which pupils? Is it desirable to let pupils decide for themselves or to have decisions made for them on the basis of the rate at which they proceed through their work?

SECTION D Towards a decision

How then is one to determine what type of teaching approach to use with a particular class, or a particular topic? We have attempted to point out to you some of the issues that need to be weighed up and certain requirements that must be met.

Nevertheless, there are two aspects of teaching which we consider need to be taken into account:

1. pupils in general appreciate a variety of learning experiences.
2. teaching should provide the opportunity for teachers to experiment.

Most teachers will be familiar with teacher-paced approaches, but may not be as familiar with pupil-paced approaches. If you haven't tried a pupil-paced programme with a class, you might like to experiment with this approach. If you do, then the planning guide in the Annex may be useful to you. However, remember that

whatever approach you use, successful learning requires active teaching.

ANNEX: PLANNING PUPIL-PACED PROGRAMMES

CONTENTS

Introduction:

- | | |
|------------------|--|
| <u>Section A</u> | Major factors to consider. |
| <u>Section B</u> | What approaches to pupil-paced instruction are possible? |
| <u>Section C</u> | Practical considerations. |
| <u>Section D</u> | Producing a programme. |
| <u>Section E</u> | Planning a topic. |
| <u>Section F</u> | Getting it working with your class. |
| <u>Section G</u> | Some Issues. |

INTRODUCTION

So you are thinking about trying pupil-pacing in your science programme. We hope this guide to planning pupil-paced programmes provides you with the kind of support you need to get started. The ideas and issues we present are based on our personal experiences with pupil-pacing, hopefully what we have learned will help you develop a programme which accounts for all foreseeable problems.¹

-
1. This Annex is largely the work of the Tokoroa based teachers in the Action Research Group (see Working Paper 46 of the Learning in Science Project, 'Report on the Science Activities Action Research Group').

SECTION A Major factors to consider

You have to make some overall planning decisions. These decisions are not peculiar to pupil-paced science learning, but unless they are clearly made you will find it difficult to produce a pupil-paced programme.

1. Syllabus:

This decision may have already been made for you because the HOD Science has laid down the syllabus in his scheme.

If you do have a choice here are some important considerations:

- will all pupils use the same syllabus?
- will I use different syllabuses for different ability levels?
- which syllabus or syllabuses?

2. Class characteristics:

You will need to know about the ranges of ability, levels of thinking, and levels of interest in science that exist in the class you are going to teach.

Use of a combination of

- past assessments
 - reports
 - objective test data (e.g. PAT tests)
- to give you this information

Discussions with your resource teacher regarding interpretation of PAT tests will also help.

3. Pupils' views and pupils' experiences

Of basic importance in a pupil-paced programme is the nature of the learning opportunities provided and the matching of these opportunities to the needs of each individual pupil. Crucial in this regard, is the establishment of an appropriate start-point in the programme for each pupil. Establishing such start-points is difficult and often (as subsequent pupil behaviour tells us) we make assumptions about pupils' understandings that are unfounded. The work of the Learning in Science Project is especially useful in this regard. For example, the project found that before beginning 4th Form work on "consumers" a series of basic questions about animals produced some interesting responses. Many pupils at this level would respond "No" to the question "Is a spider an animal?"

The project has developed a number of surveys which can be used to identify the meanings pupils have for various words used in science and/or to establish the views pupils hold for a range of events and phenomena of concern to scientists. These are available to teachers in the materials produced by the Biology, Physics and Chemistry Action Research Groups of the project.

4. Language ability

Any pupil-paced programme is largely dependent on written and visual material.

In putting together your programme you will find a need for these things:

- a. A knowledge of the pupil's reading ability and state of language development.
- b. An appreciation of the readability of the written resources that you are thinking of using.

This information can be obtained from these sources:

Informally

Test and investigate yourself. You could, for example, try books, or written units, etc. on the pupils. You will soon learn what is and is not suitable. We consider, there is no real substitute for this approach.

Formally

There are formal instruments which are sometimes used to give information in this area, PAT tests, Fry readability formula, Cloze test. However, all of these instruments have limitations and unless you are very familiar with them they can give false impressions of pupil ability and text difficulty.

5. Learning rates

The first reaction of many teachers to the idea of pupil-paced programmes is -

"They won't all have done the same work or the same amount of work!!!"

The short answer is: "That's right!" (and of course in any class they never do!) However, this is a crunch issue. You must consider this issue early in the development of your programme. It will influence your approach markedly.

Here (on the next page) are the extremes of the issue - and the middle ground - highlighted.

What you want	Consequences
Each pupil to make steady progress through work suited to them. No concern about all pupils doing the same work or the same amount of work.	- Pupil sets own work rate - No constraints on what work pupils do - No time constraints operate <u>Note:</u> linear and branched approaches can meet these requirements (see Section B).
Base your programme on a recognised syllabus (e.g. the FI-IV guide). All pupils to be exposed to the main ideas of a section of the syllabus. Pupils can revise or extend these ideas at own rate and at an appropriate level.	- Constraints are imposed by the work rate of the slower pupils - Some pupils will achieve basic core ideas only - others will be well ahead <u>Note:</u> The core ideas are best treated in a linear programme. A variety of teaching approaches is possible here. Branched programmes may be used to develop remedial and extension work.
All pupils cover the same ideas and/or material.	- The main constraint is time. Not all pupils will cover the material at the same rate. - If you proceed you can use the linear approach with a time definition attached. i.e. Do this in Period 1 then that in Period 2 etc. - If you use the branched approach you will probably have to produce the same pieces of work at several different levels.

SECTION B What approaches to pupil-paced instruction are possible?

The key decision here is:-

How much of the programme will be pupil-paced?

One of the advantages of pupil-paced instruction is that not only can pupils proceed through the parts of a programme at their own pace but it is also possible for different pupils to work through different sub-units.

Various possibilities if some pupil-pacing is to be included are:

A. Completely pupil paced

A1. Branches

Sequences of activities which are designed for each pupil according to individual needs, i.e. pupils follow a programme unique to them.

Note: Few teachers will have the time and resources to sustain this option.

A2. Linear

A sequence of activities which all pupils follow at their own rate. Check tests are used to indicate Mastery. Individual performance determines remedial and extension activities (see Model 1).

A3. Combined Approach

Here the main ideas (core) are developed in a sequence of activities organised as for a linear programme. Remedial and extension activities are organised as for a branched programme (see Model 2).

B. Partially Pupil-paced

Part of the programme is teacher-paced (with the whole class working on the same task) while other parts are pupil-paced (either linear or branched) according to pupil needs (see Model 2).

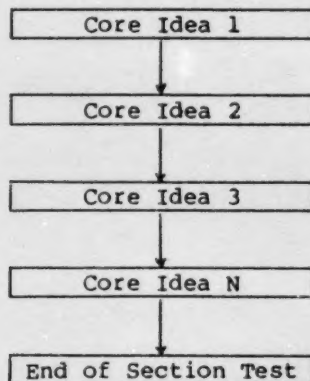
In deciding the approach you will adopt take into account,

- * the needs of your pupils
- * the way you view science teaching
- * the topic to be taught

MODEL 1 COMPLETELY PUPIL-PACED LINEAR PROGRAMME

Class is provided with a programme of activities from various resources, set out as in the model, which the pupils work through at their own rate.

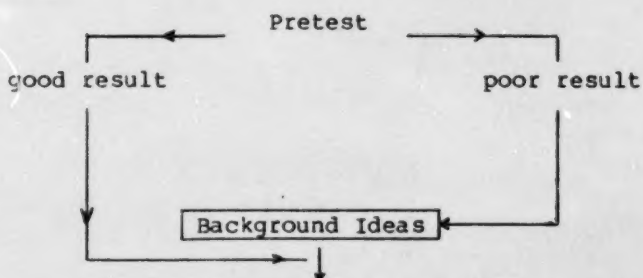
Basic programme



Additions

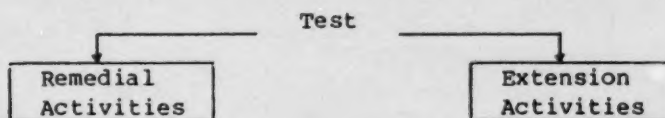
1.

Insert at the start



2.

Achievement/Check/Mastery tests can be inserted at any stage, or in any quantity, during programme



3.

"Help Cards" for skills, missing knowledge etc. can be produced as aids for students to use at any stage of the programme.

This programme is an example of a linear pupil-paced programme used by the author.

Electricity

Objectives: What you should know or be able to do at the end of each section

1. Be able to show me using a model the way 2 charged objects behave
2. Be able to describe using a model what happens when:
 - 2 like charges are brought together
 - 2 unlike charges are brought together
 - 1 uncharged object is brought close to a charged object
3. Be able to show using a model what happens when:
 - a negatively charged rod is brought close to an uncharged electroscope
 - a positively charged rod is brought close to an uncharged electroscope
4. Be able to draw:
 - the path and location of electrons in an electroscope when a charged rod is brought close to it

TEACHER INTRODUCTION

CHARGED PARTICLES

Collect: JSOP Forces and into action
Read: Pg 35-39
Do: all activities

DO: MORE ABOUT CHARGED PARTICLES
Collect: JSSP Forces and Interactions
Do: pg 42-44 JSSP

Do Progress check

0-8
correct

Do: MORE ABOUT CHARGED PARTICLES
Collect: ASEP CHARGES
Do: pg 16-17

9-10
correct

CONDUCTORS and INSULATORS
Collect: JSSP Forces and Interactions
Do: pg 45-51
Copy: Work sheet 2 into your book

SHOW YOUR WORK TO ME

Collect: Copy of JSSP Forces and interactions
Do: Moving Charges pg 58-63

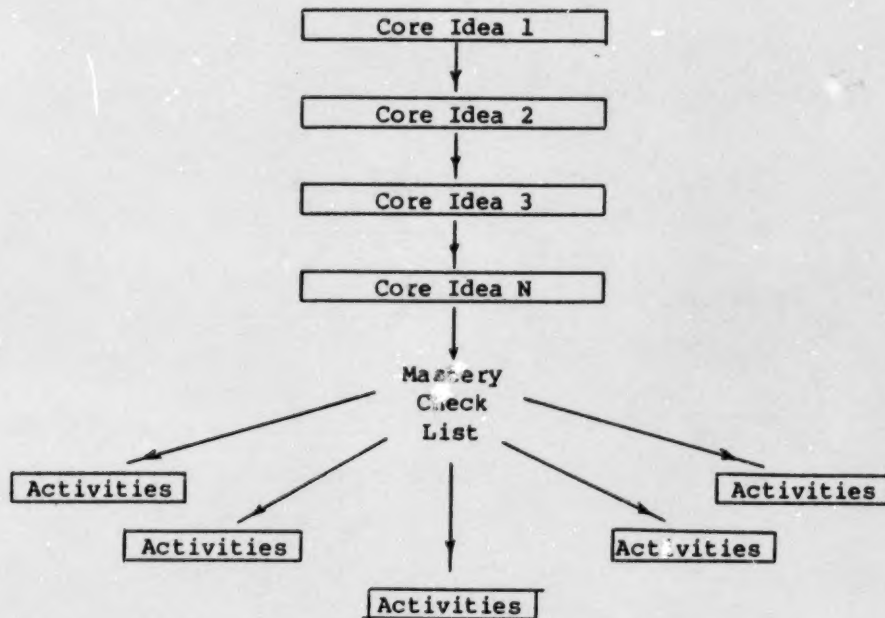
Do Progress check

Less than 10 correct 10-11 correct

Extension: Any 3
 1. Making Sparks pg 88 Forces & Int.
 2. Lightning pg 81 Forces and Int.
 3. The Blow Lamp/Charges Generators pg 13-15 ASEP Charges
 4. Another way of charging an Electroscope pg 63 Forces & Int.

MODEL 2 PUPIL-PACED PROGRAMME USING LINEAR AND BRANCHED APPROACHES

Basic programme



Notes:

A variety of teaching approaches is possible.

The Main (core) ideas can be taught:

1. by a linear pupil-paced programme
or
2. by a teacher-paced programme
or
3. a mixture of 1 and 2

The intention of the branched part of the programme is to ...

- teach subsidiary ideas
- provide remedial help for core ideas not understood
- extend core ideas

Pupils may be directed to particular branches or may choose a branch(es)

Example: This example in the lesson plan for a section of work on Earth Sciences used at fourth form level by one of the authors. The model uses variation (3) above.

UNIT: Earth Science

Approach

Core Idea 1.

EARTH SCIENCE
AND TIME

Class taught as a Group.

Core Idea 2.

ROCK CYCLE

Class taught as a Group.

Core Idea 3.

EARTH STRUCTURE

Linear

Core Idea 4.

PLATE THEORY

Pupil-paced

Core Idea 5.

LANDFORMS

Programme

Core Idea 6

LOCAL LAND
FORM

Class taught as a Group.

Core Idea 7.

LOCAL GEOLOGY

Class taught as a Group.

MASTERY TEST



Branches available

Resource

Sequence 1. Earthquakes

(TAS Earth Science)

Sequence 2. Earth's magnetism

(TAS Earth Science)

Sequence 3. History of local Volcanos

(teacher produced)

Sequence 4. Volcanos

(TAS Earth Science)

Sequence 5. Structure of the Planet

(TAS Earth Science + own)

Sequence 6. Reading Maps

(teacher produced)

Sequence 7. The Rock Cycle

(teacher produced)

(JSSP The Changing Earth)

Sequence 8. Fossils

(teacher produced)

Sequence 9. Identifying a rock

(teacher produced)

SECTION C PRACTICAL CONSIDERATIONS

To operate a self-paced programme it is necessary to consider some of the practical requirements for such a programme to operate successfully. It is desirable that children -

- Work in a familiar environment
- have ready access to resources and practical gear
- are able to interact with the above elements confidently
- have ready access to the teacher for assistance in a wide range of situations.

This means that the teacher has to have -

1. Each lesson in the same room or laboratory or some way in which the programme directions and resources are transportable or duplicated.
2. The room or laboratory organised so that children can learn to use the resources that it contains on their own.
3. The time necessary to do this organisation and produce the programme.

Note: As the teacher becomes more experienced at producing and managing programmes less preparation time is needed.

4. The versatility to change roles in the classroom to suit the needs of the children as they work.

Teacher comment

"Time ... yeah ... well at first I thought it would be too time-consuming, you know? ... I guess it was because I couldn't see the shape of the thing. But once I found a pattern to build a unit on I found ... well it didn't take as long to produce the first unit as I thought it would ... Most of the problem was accepting that kids learn at individual rates ... It was hard to see how I could cope with this at first but now I think it's easier ..."

SECTION D PRODUCING A PROGRAMME

Before you produce a programme you need to make some further decisions concerning your approach. The following questions focus on these decisions.

1. How much control do you want over the rate at which pupils work?

- how much time is available for the programme?
- how much material do you consider essential for all pupils?

2. How do you want your pupils to work?

- individually?
- in fixed groups?
- in groups formed for a specific purpose?
- in groups that form freely according to needs?
- what control do you want over the way that pupils work and interact with each other?

3. How is the work to be assigned in your programme?

Free choice:

- how will the pupils decide what they will do?
- pupils will need to learn how to select appropriate material.

Wholly prescribed:

- on what basis will you prescribe?

Partly prescribed:

- on what basis will you prescribe?
- again pupils will need to learn how to select appropriate material.

4. What will be your role when pupils are engaged in the programme?

Whatever approach you adopt, at times, you as the teacher will need to be:

- a motivator : interacting with pupils and using their ideas to promote involvement
- a guide : focusing pupils on key intellectual issues
- an instructor : demonstrating a technique, skill, etc.
: introducing a section of work or topic
: giving necessary background information
: issuing directions
- a challenger : challenging pupils' ideas and notions
- a resource person : supplying information (to individuals or the class)
: supplying resource books, sheets, gear
- a remedial person : providing guidance for specific individual or group difficulties
- an assessor : constantly checking progress
- an evaluator : checking the suitability of your programme
- a policeman : keeping the peace.

You will need to be flexible, ready to switch from one role to another as the needs of the pupils change.

5. Where are you going to get your resources and activities from?

a. Write your own materials

- you know your pupils best
- you can write to suit your style, your equipment, your room, your view of science
- a disadvantage is that this is time consuming
- refer to sections on planning (E) and Individual Differences (G) for specific concerns.

b. Use existing materials

- which materials? (texts, work sheets, etc.)
- what will you need to do to ensure
 - balance?
 - links between activities?
 - appropriateness of material?

c. Use a ready made course:

- does it satisfy your aims and objectives?
- is it balanced and suitable for your pupils?
- will it fit your room and resources?

You may, of course, use all three approaches at various times depending on your needs. The important factor is that resources must match the ability of your pupils.

6. What sort of work packages are you going to prepare?

a. Individual activities

These are activities which last 1 -2 periods.

Such work packages are well suited -

- to establish the views held by pupils
- to introduce a core idea
- establish a subsidiary idea
- remediate missing skills, knowledge, etc.
- revise partly understood main ideas
- extend main ideas.

b. Short sequence of activities

A short sequence of related activities (typically 2 - 5 periods)

- a. suited to the need to teach a specific piece of work e.g. the core or a part of the core of a programme.
- b. extension or remedial activities.

c. Long Sequences

Sequences of related activities (typically 5 - 15 periods).

A linear programme is such a sequence.

Note: In any sequence you will need to think about how you will keep in touch with your pupils progress through the activities.

7. How are you going to ensure that the intended learning experience is the actual learning experience?

First you must be perfectly clear in your own mind what the objective of each part is, and establish a strategy whereby this objective can be made perfectly clear to pupils. One way of achieving this is to explicitly state specific objectives (see Model 1 example p.16).

8. How much variety should there be in your programme?

The programme should include a wide variety of activities for at least two reasons:

1. It is generally agreed that a variety of learning experiences should be included to sustain interest and motivation in any teaching programme.
2. The number of sets of any particular resource e.g. equipment, etc. can be less if there are a variety of activities which pupils will carry out at different times.

The variety of activities possible, include

- practical exercises
- data handling
- theory reading
- problem solving
- research
- comprehension
- homework

SECTION E PLANNING A TOPIC

The following system of planning is one that we have found particularly useful in developing pupil-paced programmes.

1. Decide what your "package" of work is to be.
2. Sort out the main ideas - this will be your core - all pupils will be exposed to these ideas.
3. Decide what is an appropriate level of mastery for these main ideas.
4. Sort out the subsidiary ideas - these form your options, extensions etc.
5. Select or write material to develop core ideas - decide activities and assemble resources for your programme.
6. Decide which skills, techniques etc. might need specific teaching and fit these into the core at an appropriate place.
7. Plan achievement/check/mastery tests.
8. Select or write material for subsidiary ideas, remedial, revision and extension work. Decide activities and assemble resources.

Note:

Although all authors find this basic system useful, each employs it in a different way. For example ...

One approach

"I tend to work through steps 1 - 4 and produce and outline plan. This means that the questions in Section D tend to be answered after I have done my basic planning. I arrange the actual activities to suit the way I see the class and the material. I make my decisions on work packages, approaches, extent of individualization etc. towards the end of the planning process. Then I look for suitable resources. If I can't find them in books etc., I write the ones I need."

Another approach

"I agree with the basic format but give a greater priority to certain aspects. 1 and 2 are basic planning sequences which are necessary for planning my section of work. I amplify 2 by stating objectives that I wish the students to achieve and flow chart these out on paper. I then consider the resources available. We have a very wide range - as a consequence I am interested in those which have the same or very similar ideas but which are written at different reading levels e.g. diagrams for dependent readers, the references for these I place on a flow chart beside the objectives. At this point I consider the skills and knowledge necessary for each step and add to the programme appropriate check tests. I then consider remedial/extension work.

The Section D questions are answered during the preparation. Presentation of programme to students via a large wall chart.

SECTION F GETTING IT WORKING WITH YOUR CLASS

This section considers the issues you will need to consider in implementing the programme you have planned.

1. Organising your room:

To save yourself and your pupils time and frustration, your room needs to be organised so that the pupils can use it without close supervision or constant direction. The key to this is that pupils come to know where the equipment and materials for any activity may be. This means -

- a. the location of equipment is clearly indicated;
- b. resources and equipment that are needed and are not normally available in the room are organised and accessible;
- c. the clean up materials are available.

2. Teaching the pupils to use the programme:

This approach is new to your pupils as well. They will need to be taught how to use the programme. It will take them a while to feel secure with a programme that places emphasis on their work and organisational skills.

In particular they will have to be taught some, or all, of the following:

- a. What the programme is designed to do.
- b. How to follow the programme and use the programme materials.
- c. What your role is.
- d. How your room is set up.
- e. What the assessment procedures are.
- f. How their progress is measured and/or monitored.
- g. What routines they need to adopt.
- h. What to do when they strike difficulties.
- i. How to clean the room.
- j. Equipment and resource management skills.

3. Social Responsibilities

You might like to give some thought to the questions of social responsibilities in your class.

These responsibilities can be identified, specified and pupils assigned to carry them out on a rota basis.

The way pupils carry out these responsibilities might be considered as fair items to include in your assessment kit.

Some possible social responsibilities are:

- a. Equipment issue, retrieval and checking
- b. Book issue, retrieval and checking
- c. Dispensing chemicals
- d. Clean up supervision
- e. Damage and breakage control
- f. Instructors in specific equipment use or techniques.

4. Progress Checking:

How will you know what the pupils are learning? Keeping a check on the pupils progress and their achievements is the aim of your assessment kit.

However, the question of progress and your control over it, or checking on it, needs to be faced before pupils start on the programme. It is important to have set procedures for doing this as your pupils will at times be achieving different things at different levels.

Here are some methods that you might think about. All of these have been used successfully. We frequently use these methods concurrently.

a. Assessment Book - This involves keeping a note book in which you record test results, observations, progress notes on each pupil in your class.

b. Mastery Tests - These are much the same as check tests or achievement tests. They can be used to check progress in understanding ideas or mastering skills at any stage of a programme.

In Model 2 - quoted earlier - a mastery test is used to do this and forms the basis for prescribing remedial, revision and extension work. The results can be qualitatively or quantitatively assessed according to your needs.

c. Looking at Work - An important way of checking on progress is to look at, and take note of, the work the pupils are producing. For instance;

- i. In the branched approach you may insist that you sight each piece of work before a pupil progresses to the next.
- ii. In any programme you may include a "report to your teacher with your work" instruction. These are particularly useful to use at critical points in a programme.
- iii. One approach used particularly with short or medium length sequences of work on one topic is this. The first activity of the sequence is issued; when each pupil completes it he brings his work to you and if you are satisfied you issue the next activity in the sequence - and so on. This method will allow close supervision over all pupils progress.

SECTION G SOME ISSUES

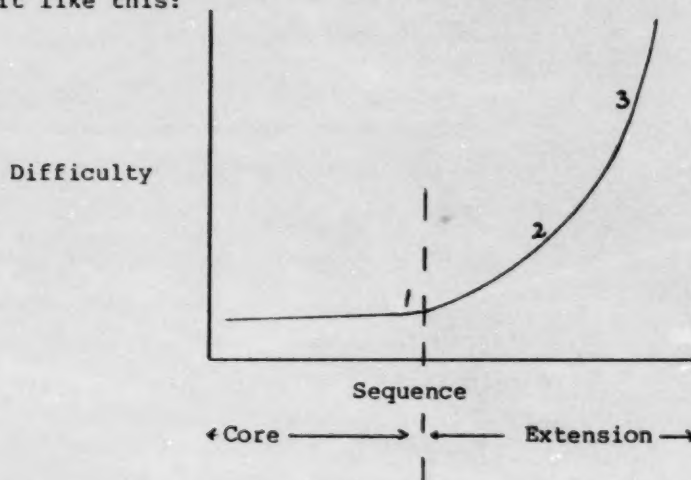
These are some points that are frequently raised when pupil-paced approaches are discussed. Here are some views based on the personal opinions of the authors.

- a. You will continually need to search for effective ways to check that pupils actually have the learning activities intended and, for assessment mechanisms which will provide valid, reliable and useful information about which parts of the programme any individual should be exposed to (which branch for which pupil).
- b. You may have to accept that for slower pupils their lack of basic learning skills will get in the way of their science learning. You have two choices; plug on, or tackle the problem, i.e. teach them the missing skills yourself or seek help from remedial specialists in your school for them.
- c. For brighter kids one of the essential skills to develop is the self-teaching skill. Activities which stretch their ability, appeal to their creativity and which encourage independent science learning skills go a long way towards enhancing the development of students.
- d. If you allow groups in your room to form according to needs or activities etc. then you may notice brighter pupils adopting a resource role. This you might like to encourage - there is nothing like trying to teach something to someone to promote understanding.
- e. There is a noticeable pull effect exerted on slower pupils by brighter pupils in classrooms in which the emphasis is on the individual's development, and not on success measured against an arbitrary standard. In our experience the reverse effect does not operate.
- f. When designing a programme it is worth bearing in mind that the brighter pupils will progress much faster than slower pupils. What do you do? You need to provide extension work.

There are three ways of providing extensions:

- increase volume of work at the same difficulty
- widen scope of work
- deepen scope of work

One approach that we use is based on the idea that the difficulty of the work towards the end of a sequence increases sharply. You might picture it like this:



The aim is that:

Slower pupils reach here (1)

Average pupils get a bit further and face greater challenges (2)

Brighter pupils get still further and face even greater challenges (3)

All pupils can be successful.

- g. For less able pupils many of the problems revolve around the high dependence of pupil-paced programmes on written material. Systems for making instructional material easier to cope with will help all pupils but these pupils especially. Some ways we have used include -

- highly diagrammatic material
- listening posts
- asking students to order disordered instruction
- using buddy systems
- directed silent reading.